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Indian Standard
SPECIFICATION FOR
ABRASION-RESISTANT IRON CASTINGS
(*Second Revision*)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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Indian Standard

SPECIFICATION FOR ABRASION-RESISTANT IRON CASTINGS

(Second Revision)

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Indian Standard

SPECIFICATION FOR ABRASION-RESISTANT IRON CASTINGS

(Second Revision)

0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 26 December 1985, after the draft finalized by the Pig Iron and Cast Iron Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was first published in 1968 and revised in 1972. As a result of further experience gained during these years, the standard has been revised again incorporating provisions in regard to chemical analysis and making the hardness values mandatory.

0.3 Iron castings included in this standard have good resistance to both low- and high-stress abrasion in the application of mining, milling, earth moving and manufacturing industries. These iron castings are expected to have a microstructure of carbides in a matrix of martensite, bainite and austenite and essentially free from pearlite. They are expected to be free from graphite except where its presence is intentionally desired for specific applications.

0.3.1 Attempts are being made to develop commercially nickel and molybdenum-free abrasion-resistant iron castings which may be included in this standard at a later date.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the requirements of abrasion-resistant iron castings.

*Rules for rounding off numerical values (revised).

1.2 Iron castings consisting essentially of iron carbide and pearlite are excluded from this standard irrespective of alloy content.

2. GRADE

2.1 Abrasion-resistant iron castings shall be of the following grades:

<i>Type</i>	<i>Chemical Name</i>	<i>Designation</i>
1a	Nickel-chromium martensitic white iron	NiLCr 30/500, NiLCr 34/550
1b	Nickel-chromium martensitic white iron	NiHCr 27/500, NiHCr 30/550, NiHCr 34/600
2	Chromium-molybdenum martensitic white iron	CrMoHC 34/500, CrMoLC 28/500
3	High-chromium white iron	HCrNi 27/400, HCr 27/400

NOTE 1 — The grades under Type 1 are designated by the letters NiLCr and NiHCr to represent nickel containing low-chromium and nickel-containing high-chromium iron respectively. The grades under Type 2 are designated by the letters CrMoHC and CrMoLC to represent high carbon and low carbon varieties of chromium-molybdenum irons respectively. The grades under Type 3 are designated by the letters HCrNi and HCr to represent nickel containing and nickel-free high-chromium white irons respectively.

NOTE 2 — These types are further designated by two digits to represent mean carbon content of the range and three digits to represent the minimum Brinell Hardness, the example, NiLCr 30/500 means a low-chromium grade with carbon in the range 2.7-3.3 percent and having a minimum Brinell Hardness of 500 HBW.

3. SUPPLY OF MATERIAL

3.1 General requirements relating to the supply of abrasion-resistant iron castings shall be as laid down in IS : 1387-1967*.

4. MANUFACTURE

4.1 The castings shall be made by any suitable melting process.

5. CHEMICAL COMPOSITION

5.1 The chemical composition of the metal for different grades of abrasion-resistant iron castings shall be as given in Table 1.

6. CHEMICAL ANALYSIS

6.1 Chemical analysis for the determination of various constituents in casting shall be done in accordance with IS : 228-1959†.

*General requirements for the supply of metallurgical materials (first revision).

†Methods of chemical analysis of pig iron, cast iron and plain carbon and low alloy steels (revised).

TABLE 1 CHEMICAL COMPOSITION OF ABRASION-RESISTANT IRON CASTINGS (PERCENT)

(Clause 5.1)

CONSTITUENT	TYPE 1A		TYPE 1B			TYPE 2		TYPE 3	
	NiLCr 30/500	NiLCr 34/550	NiHCr 27/500	NiHCr 30/550	NiHCr 34/600	CrMoHC 34/500	CrMoLC 28/500	HCrNi 27/400	HCr 27/400
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Total carbon	2.7 to 3.3	3.2 to 3.6	2.5 to 2.9	2.8 to 3.3	3.2 to 3.6	3.1 to 3.6	2.4 to 3.1	2.3 to 3.0	2.3 to 3.0
Silicon	0.3 to 0.6	0.3 to 0.6	1.5 to 2.2	1.5 to 2.2	1.5 to 2.2	0.3 to 0.8	0.3 to 0.8	0.2 to 1.5	0.2 to 1.5
Manganese	0.3 to 0.6	0.3 to 0.6	0.3 to 0.6	0.3 to 0.6	0.3 to 0.6	0.4 to 0.9	0.4 to 0.9	1.5 Max	1.5 Max
Nickel	3.0 to 5.5	3.0 to 5.5	4.0 to 6.0	4.0 to 6.0	4.0 to 6.0	0.5 Max	0.5 Max	1.2 Max	0.5 Max
Chromium	1.5 to 2.5	1.5 to 2.5	8.0 to 10.0	8.0 to 10.0	7.5 to 9.5	14.0 to 18.0	14.0 to 18.0	24.0 to 28.0	24.0 to 28.0
Molybdenum	0.5 Max	0.5 Max	0.5 Max	0.5 Max	0.5 Max	2.5 to 3.5	2.5 to 3.5	0.6 Max	0.6 Max
Sulphur, Max	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Phosphorus, Max	0.3	0.3	0.3	0.3	0.3	0.3	0	0.3	0.3
Remainder	←----- Essentially iron ----->								

NOTE 1 — For Types 1a and 1b, low-nickel, high-silicon and low-chromium contents are preferred for the smaller sections. High-nickel, low-silicon and high-chromium contents are preferred for the heavier sections.

NOTE 2 — Toughness and resistance to repeated shock increase as carbon content decreases.

NOTE 3 — Resistance to abrasive wear increases as carbon content increases.

7. WORKMANSHIP AND FINISH

7.1 The castings shall be accurately moulded in accordance with the pattern or working drawings supplied by the purchaser, with the addition of such letters, figures and marks as may be specified.

7.2 The drawings shall specify tolerances on all important dimensions.

8. MICROSTRUCTURE

8.1 Castings or suitable test samples may be subjected to metallographic examination if agreed to between the purchaser and the manufacturer. Location of test samples and area used for examination shall be decided by mutual agreement of the purchaser and the manufacturer.

8.2 The microstructures of all abrasion-resistant irons depend on cooling rate and are therefore sensitive to section size.

9. HEAT-TREATMENT

9.1 Castings shall be supplied either in the as-cast or heat-treated condition at the discretion of the manufacturer to meet the hardness requirements specified in 10.1 or as specified by the purchaser.

9.2 If required, Type 1a castings shall be heat-treated for 12 to 16 hours at 200 to 275°C followed by air or furnace cooling. Where optimum properties are required, particularly under severe conditions of repeated impact, a double heat-treatment for 4 to 8 hours at 425 to 475°C followed by air cooling and holding 12 to 16 hours at 200 to 275°C shall be preferred.

9.3 If required, Type 1b castings shall be heat-treated for 6 to 12 hours at 775 to 825°C, followed by air or furnace cooling. This heat-treatment conditions the austenite for transformation to martensite and bainite to develop a good combination of hardness, strength and resistance to repeated impact. At the request of the purchaser, or at the discretion of the manufacturer, these grades may be subsequently tempered at 200 to 350°C for 4 hours. This heat-treatment toughens the iron and increases resistance to spalling.

9.4 When specified by the purchaser, the manufacturer shall anneal castings of Type 2 and Type 3 grades to provide a maximum surface hardness of 380 HBS before giving hardening treatment.

NOTE — A recommended annealing procedure for castings of Type 2 and Type 3 is described below:

- a) Heat slowly to 920 to 975°C;
- b) Hold at this temperature for not less than 1 hour;
- c) Furnace-cool to 810 to 815°C;
- d) Further cool in furnace to 590 to 645°C, cooling rate not to exceed 40°C/h; and
- e) Cooling below 590°C may be in furnace or still air.

9.5 When specified by the purchaser, the manufacturer shall harden the castings of Type 2 and 3 by heating to a suitable temperature for a minimum of 1 h/250 mm of section thickness, but in no case for less than 1 hour, followed by air cooling. The austenitizing temperature for this hardening treatment shall be between 950 and 1 010°C for the Type 2 irons and between 980 and 1 120°C for Type 3 irons. The same procedure may also be used for hardening annealed and machined castings.

9.6 Both annealing and hardening treatments shall not be specified for castings of Type 2 and Type 3 grades. If annealing is specified for these grades, it is expected that the purchaser will carry out both machining and hardening operations.

10. HARDNESS

10.1 The material shall conform to the requirements stipulated in Table 2.

TABLE 2 MINIMUM BRINELL HARDNESS VALUES (HBW) OF ABRASION-RESISTANT IRON CASTINGS

CONDI- TION	TYPE 1A		TYPE 1B			TYPE 2		TYPE 3	
	NiLCr 30/500	NiLCr 34/550	NiHCr 27/500	NiHCr 30/550	NiHCr 34/600	CrMoHC 34/500	CrMoLC 28/500	HCrNi 27/400	HCr 27/400
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sand-cast	500	550	500	550	600	500	500	400	400
Hardened	—	—	—	—	—	600	550	550	550
Annealed	—	—	—	—	—	380 Max	380 Max	—	380 Max

NOTE — Minimum hardness values up to 50 Brinell points lower than those specified in this table shall be permitted in castings with section thickness greater than 125 mm.

10.1.1 The hardness test shall be carried out in accordance with IS : 1500-1983* using tungsten carbide ball.

11. SAMPLING

11.1 For quality control during production, use of control chart technique is recommended to the manufacturer for which reference is invited to IS : 397 (Part 1)-1972† or IS : 397 (Part 2)-1975†. The results of such

*Method for Brinell hardness test for metallic materials (second revision).

†Method for statistical quality control during production:

Part 1 Control charts for variables (first revision).

Part 2 Control charts for attributes and count of defects (first revision).

tests done at the place of manufacture along with the material supplied may be made available, to enable the purchaser to judge its acceptability.

11.2 Sampling for Chemical Analysis — Chemical analysis shall be carried out either on finished casting or test bar representing each melt. In the case of continuous melting, samples shall be provided at the rate of one sample per hour of production.

11.3 Sampling for Hardness Test — If specified by the purchaser, test shall be carried out either on finished casting or test bar representing each heat-treatment batch; at least one test shall be carried out from each melt in case the castings from two or more melts are heat-treated in one batch. In the case of continuous melting, sufficient number of samples shall be provided to ensure at least one test per hour of production.

12. RETEST

12.1 Chemical Analysis — If a sample selected under 11.2 fails to meet the requirements given in Table 1, the purchaser shall select two further samples from the same lot. If both the samples satisfy the specified requirements, the castings represented shall be accepted. If either of the samples fails, the castings represented shall be deemed as not complying with this standard.

12.2 Hardness Test — If a sample selected under 11.3 fails to meet the requirements given in Table 2, two further samples shall be selected from the same lot and in case the castings have been heat-treated from the same heat-treatment batch. The consignment shall be considered to conform to the requirements if both the additional tests are satisfactory. Should either of the samples fail, the castings represented shall be deemed as not complying with this standard. If the castings are supplied in the heat-treated condition, the manufacturer shall have the right to reheat-treat the product, if he so desires, in any suitable manner before two fresh samples are taken for testing. Should the two tests satisfy the requirements of this standard, the lot shall be accepted. Should either of the samples fail, the castings represented shall be taken as not complying with this standard.

13. MARKING

13.1 Where practicable, each casting shall be legibly marked with an identification mark by which it can be traced to the melt and the batch of heat-treatment, where applicable, from which it was made.

13.2 By agreement between the purchaser and the manufacturer, castings complying with the requirements of this standard, may, after inspection, be legibly marked with an acceptance mark.

13.3 The castings may also be marked with the ISI Certification Mark.

Note — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

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